The Elements of Avicenna's Physics
Greek Sources and Arabic Innovations

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Preface

This study considers itself to be an examination of texts of historic value, most notably those composed by the philosopher Avicenna (d. 428/1037). For this reason, it relies heavily on quoting, reading, translating, and understanding passages from primary texts. The following rules have been adopted in presenting and working with these passages.

Passages in quotation are presented in their original language together with an English translation. In the case of Aristotle, texts are quoted in Greek and English together with a historical Arabic translation, if available.[1] Given that some of Aristotle's works have been the subject of multiple translations into Arabic, together with the lack of reliable, or in any way precise, information about which translations Avicenna used and knew, it must be noted that the Arabic version of passages from Aristotle quoted in this study may not necessarily be the version which Avicenna was most familiar with or primarily worked from. This is particularly true in the case of the *Physics*.[2] At the same time, it should be clear that the addition of simply *any* Arabic translation provides a modern interpreter with valuable information about a certain terminology and understanding which has been used to render the Greek text into Arabic during times not too distant from Avicenna's life.

In this regard it is to be noted, too, that the historical Arabic translations may naturally deviate from our established Greek texts in various respects. Such differences are only occasionally mentioned, as it is not the subject of this study to assess the quality and accuracy of the Graeco-Arabic translations. Moreover, such remarks are clearly only of limited value in a study on Avicenna's philosophy as long as we continue to lack reliable information on which translations he primarily relied on in his philosophical education and formulation.

All Greek texts are quoted following the available, often critical, editions listed in the bibliography. Arabic texts are quoted on the basis of the available, rarely critical, editions

1 If a quoted passage is provided in three languages, the English translation at the *bottom* always translates the version on *top*, and not any of the versions in the middle between these. Thus, if the order of the versions of a given passage is Greek-Arabic-English, then the English translation at the bottom renders the Greek text on top, but if the order is Arabic-Greek-English, then the English translation at the bottom renders the Arabic text on top.

2 This will be discussed briefly below, 29ff.

listed in the bibliography but have silently been adapted so as to conform to a consistent orthography and punctuation.

The transliteration of Arabic terms follows, for the most part, the rules laid down by the Deutsche Morgenländische Gesellschaft. Exceptions include the handling of sun letters (e.g., *al-ṭabīʿa* instead of *aṭ-ṭabīʿa*) and of diphthongs (*aw* and *ay* instead of *au* and *ai*). In the transliteration of Persian terms, I decided not to classicise the spelling (e.g., *ketāb* instead of *kitāb*), taking my cue from contemporary pronunciation.

Furthermore, I took the liberty to add Greek and Arabic terms in square brackets at any time and to any quotation, be that from primary texts or from the secondary literature. Likewise, have I allowed myself to remove any such earlier addition by the original editor, translator, or author from a quoted passage, if I deemed it inadequate or distracting.[3]

It often happens that I quote from an earlier translation and indicate that this translation has been modified. This can mean either that the text of the earlier translation has been *slightly* modified (such as changing the tense of a verb or replacing a noun) or that it has been *heavily* modified (such as changing the structure of the entire sentence). In fact, most quoted translations have been modified, not only in order to provide what I consider to be a better or more correct translation, but also to obtain a clear and straightforward terminology throughout this study. Terms such as ἀρχή and *mabdaʾ*, for example, have been translated usually and consistently as "principle," even though other translators opted, in various contexts, for different expressions such as "beginning," "source," and "origin."

In my own translations, I often strove to follow the Arabic original closely, even in its syntax and word order. The resulting translations may appear to be less fluent, or pleasant, in English but, so I hope, no less adequate for a thorough examination of text, thought, and terminology.

As a rule, references to primary texts always indicate the title of the work, the part, the chapter, and the subsection, if applicable, to which a certain passage refers or from which a given translation has been taken *in addition* to page numbers with line or paragraph numbers. It is my sincere believe that modern scholarship would benefit from a strict observance of this rule.

Aristotle's works are referenced with their well-known English or Latin titles, for example, *Posterior Analytics*, *Physics*, *De generatione et corruptione*, and *De anima*. Corresponding titles of Avicenna's works are always given in their transliterated Arabic form, for example, *al-Burhān*, *al-Samāʿ al-ṭabīʿī*, *al-Kawn wa-l-fasād*, and *al-Nafs*. Titles of Arabic works of other authors whose title is identical with, or too similar to, one of Avicenna's works, are given in English translation, in an attempt to avoid confusion; the *Kitāb al-Burhān* of Abū Naṣr al-Fārābī, for example, is quoted as *Book of Demonstration*.

3 In like manner do I quote from Gutas' *Avicenna and the Aristotelian Tradition* without keeping the capitalisation of technical terms, which is pointless to retain anywhere outside the original work.

With regard to Aristotle's works, I quote from the following Arabic translations:

- *Categories*: Isḥāq ibn Ḥunayn on the basis of a Syriac version by his father Ḥunayn ibn Isḥāq; published by Badawī and by Ǧabr.
- *Posterior Analytics*: Abū Bišr Mattā ibn Yūnus on the basis of a Syriac translation by Isḥāq ibn Ḥunayn; published by Badawī and by Ǧabr.
- *Rhetorics*: An unknown translator; published by Lyons.
- *Physics*: Isḥāq ibn Ḥunayn presumably on the basis of a Syriac translation either by himself or by his father Ḥunayn ibn Isḥāq; published by Badawī.[4]
- *De caelo*: Yaḥyā ibn al-Biṭrīq on the basis of an unknown Syriac translation; published by Badawī.[5]
- *De anima*: An unknown translator, erroneously attributed to Isḥāq ibn Ḥunayn; published by Badawī.[6]
- *De partibus animalium*: An unknown translator, erroneously attributed to Yaḥyā ibn al-Biṭrīq, on the basis of an unknown Syriac translation; published by Kruk.[7]
- *De generatione animalium*: An unknown translator, erroneously attributed to Yaḥyā ibn al-Biṭrīq, on the basis of an unknown Syriac translation; published by Brugman and Drossaart Lulofs.[8]
- *Metaphysics*: Primarily Usṭāṯ, preserved in the lemmata of Averroes' *Tafsīr Mā baʿda l-ṭabīʿa*; published by Bouyges.[9]
- *Nicomachean Ethics*: partially Isḥāq ibn Ḥunayn, probably on the basis of a Syriac version by his father Ḥunayn ibn Isḥāq, and partially by Usṭāṯ; published by Badawī and by Akasoy and Fidora.[10]

With regard to Avicenna's works, I use the following editions and cite according to the following pattern:

- *al-Ḥikma al-ʿArūḍiyya*: Title, part, chapter, page, line; following Ṣāliḥ's edition.
- *ʿUyūn al-ḥikma*: Title, part, chapter, page, line; following Badawī's first edition from 1954.

4 For more information on the transmission of Aristotle's *Physics*, q.v. below, 9ff.

5 cf. Endreß, "Die arabischen Übersetzungen von Aristoteles' Schrift De Caelo".

6 For a discussion of the attribution to Isḥāq ibn Ḥunayn, cf. Frank, "Some Fragments of Isḥāq's Translation of the *De anima*"; Gätje, *Studien zur Überlieferung der aristotelischen Psychologie im Islam*, 20–44

7 For a discussion of the attribution to Yaḥyā ibn al-Biṭrīq, cf. the remarks by Brugman and Drossaart Lulofs as well as Kruk in their respective editions of the Arabic translations of Aristotle's *De generatione animalium* and *De partibus animalium*.

8 q.v. the preceding footnote.

9 For a discussion of the various translations of Aristotle's *Metaphysics* and of those preserved in Averroes' commentary, cf. Bertolacci, *The Reception of Aristotle's* Metaphysics *in Avicenna's* Kitāb al-Šifāʾ, ch. 1, being a moderately reworked version of his earlier article "On the Arabic Translations of Aristotle's *Metaphysics*".

10 For the textual transmission of the *Nicomachean Ethics*, cf. the extensive discussion in Ullmann, *Die Nikomachische Ethik des Aristoteles in arabischer Überlieferung*.

- *Kitāb al-Ḥudūd*: Title and paragraph; following Goichon's edition.
- *al-Mabdaʾ wa-l-maʿād*: Title, part, chapter, page, line; following Nūrānī's edition.
- *al-Hidāya*: Title, part, chapter, page, line; following ʿAbduh's edition.
- Works from *al-Šifāʾ* are quoted by title, book, chapter, page, line; following the Cairo edition of *al-Šifāʾ*; with the exception of:
  - *al-Samāʿ al-ṭabīʿī*: Title, book, chapter, paragraph; following McGinnis' edition and translation.
  - *al-Ilāhiyyāt*: Title, book, chapter, paragraph; following Marmura's edition and translation.
- *al-Naǧāt*: Title, part, section chapter, page, line; following Dānešpažūh's edition.[11]
- *Dānešnāme-ye ʿAlāʾī*: Title, part, chapter, page, line; following the editions by Moʿīn and Meškāt.
- *al-Išārāt wa-l-tanbīhāt*: Title, part, chapter, section, page, line; following Forget's edition.[12]
- *al-Mubāḥaṯāt*: Title and paragraph; following Bīdārfar's edition.
- *al-Taʿlīqāt*: Title and paragraph; following Mousavian's edition.

Occasionally, I have compared the editions of Avicenna's works, in particular of his *al-Šifāʾ*, with manuscripts containing them.[13] My comparison did, however, not follow any systematic rule nor did I consistently compare every quotation. I drew upon the manuscripts only when the text established by the editions appeared to be especially dissatisfying. In a number of cases, I preferred readings found in these manuscripts to those found in the editions. These cases are always noted in the footnotes.

Two final remarks: First, in my footnotes, I use the Latin abbreviation "cf.," in order to refer to further evidence in another work or study. I did not intend to observe and to emulate the fine distinction between "see" and "cf." and, for this reason, only use the latter.

11 Dānešpažūh's division of the work into eleven *aǧzāʾ* (sg. *ǧuzʾ*) should not be retained, as that division has no correspondence whatsoever with the content of the work and merely reflects some division – presumably into quires (*aǧzāʾ*)? – of the manuscript (manuscript *dāl*) which Dānešpažūh used as the basis for his edition; cf. his remarks in the introduction to his edition (xcix). Other than that, Dānešpažūh did not edit the part on mathematics, which in his edition is provided only in form of a facsimile from manuscript *dāl*, perhaps because this part has not been written by Avicenna himself but was compiled by his closest disciple Abū ʿUbayd al-Ǧūzǧānī; cf. Gutas, *Avicenna and the Aristotelian Tradition*, 422–424.

12 Avicenna's *al-Išārāt wa-l-tanbīhāt* is commonly referenced as if it were a work consisting of four parts, viz., logic, physics, metaphysics, and mysticism. This fourfold division seems to have been introduced through Dunyā's four-volume edition of the text and gained prominence through the widespread use of that edition. This, however, is a habit which is entirely mislead and must be avoided. Avicenna's *al-Išārāt wa-l-tanbīhāt* does not consist of four but of two parts, viz., logic and all the rest, and should be quoted accordingly.

13 Especially the manuscripts Leiden or. 4 and or. 84 proved to be helpful in assessing the text of the Cairo edition of *al-Šifāʾ*. Neither of them has been taken into consideration by previous editors of *al-Šifāʾ*. On these manuscripts, cf. Witkam, "Avicenna's Copyists at Work".

Secondly, the fact that I do not make use of feminine pronouns when, mostly for rhetorical reasons, I refer to a generic person ("someone might claim … but *he* would be wrong") should not be interpreted as displaying a sexist or anti-feminist stance. With my native German background, I find it more convenient and less distracting to use masculine pronouns, hoping that the reader is not offended by this idiosyncrasy or – failing that – accepts my sincere apology.

Introduction

The aim of this doctoral dissertation is to analyse the core concepts of Avicenna's physics. Particular attention shall be given to the work *al-Samāʿ al-ṭabīʿī*, which is the first section (*fann*) of the second part (*ǧumla*) of Avicenna's voluminous and comprehensive *al-Šifāʾ* and, by all appearance, was the first section to be written and completed around 412/1022. In this work, Avicenna formulates his most extensive account of physics in general, and of the concepts of matter and form, nature, motion, place, and time in particular. It is for this reason that Avicenna's *al-Samāʿ al-ṭabīʿī* is at the heart of this study.

Avicenna also authored a number of less exhaustive, even if not necessarily less complete, philosophical compendia, viz., *al-Ḥikma al-ʿArūḍiyya*, *ʿUyūn al-ḥikma*, *al-Hidāya*, *al-Naǧāt*, *Dānešnāme-ye ʿAlāʾī*, and *al-Išārāt wa-l-tanbīhāt*. Some of these works have been neglected by modern scholarship almost in their entirety.[1] In this study, it is my firm intention to consider all these seven works, and to compare, contextualise, and assess their respective contents in an attempt to provide a full and coherent picture of the key concepts of Avicenna's natural philosophy. In addition to that, other sections of *al-Šifāʾ*, in particular *al-Ilāhiyyāt*, *al-Samāʾ wa-l-ʿālam*, *al-Kawn wa-l-fasād*, *al-Burhān*, and *al-Maqūlāt*, will often be consulted, as they provide important information without which many details cannot adequately be evaluated or even understood.[2]

Avicenna's *al-Samāʿ al-ṭabīʿī* is neither a commentary on Aristotle's *Physics* nor is it an interpretation of that work. It is more adequately described as Avicenna's own version of that science whose subjects have traditionally been transmitted and discussed under the title of Aristotle's Greek work *Φυσικὴ ἀκρόασις*, in Arabic *Samʿ al-kiyān* or *al-Samāʿ al-ṭabīʿī*, in English *Lecture on Physics* or simply *Physics*. According to Avicenna's understanding, the subjects discussed in Aristotle's work belong to, and make up, the science of "physics," which he conceives as the most common science or discipline within the area of natural

1 This is particularly true of *al-Ḥikma al-ʿArūḍiyya*, *ʿUyūn al-ḥikma*, *al-Hidāya*, and *Dānešnāme-ye ʿAlāʾī*, while *al-Naǧāt* and, especially, *al-Išārāt wa-l-tanbīhāt* now have spurred the interest of scholars. Of these, only *al-Išārāt wa-l-tanbīhāt* and the *Dānešnāme-ye ʿAlāʾī* have completely been published in modern translation.

2 It is a perplexing datum of reality that, despite the commonly acknowledged importance of *al-Šifāʾ* as such, most of its contained works have so far not been published in modern translation and are often only marginally treated – if at all – by western scholars. Notable exceptions include *al-Ilāhiyyāt* (of which several translations exist) and *al-Samāʿ al-ṭabīʿī* (of which McGinnis published a full English translation in 2009).

philosophy. With regard to Avicenna's *al-Šifāʾ*, then, the contents of *al-Samāʿ al-ṭabīʿī* lay the foundation for the more specific investigations carried out in the particular disciplines presented in *al-Samāʾ wa-l-ʿālam*, *al-Kawn wa-l-fasād*, *al-Afʿāl wa-l-infiʿālāt*, *al-Maʿādin wa-l-āṯār al-ʿulwiyya*, *al-Nafs*, *al-Nabāt*, and *al-Ḥayawān*.[3] Together, these eight disciplines complete the scientific area of *al-Ṭabīʿiyyāt*: the philosophy concerned with "natural [things]" – i.e., natural philosophy.

Since Avicenna's various works on physics provide us with insights into his personal reading of Aristotle's *Physics*, and into his own appropriation of Aristotelian physics and natural philosophy, any engagement with Avicenna's texts recommends a preceding engagement with Aristotle's writings on these subjects as well as with a range of works from the philosophical tradition they initiated. It is for this reason that in this study, I shall make constant use of Aristotle's *Physics* and of a number of Greek and Arabic sources which, in one way or another, expound or comment on Aristotle's work, in order to understand and contextualise the various views and positions which Avicenna presents and discusses in his major works and especially in his *al-Samāʿ al-ṭabīʿī*. I shall never intend, however, to engage in an attempt to understand or to interpret Aristotle's *Physics* on the basis of Avicenna's works. To put it simply: Aristotle's *Physics* is a valuable resource for understanding Avicenna's *al-Samāʿ al-ṭabīʿī* – and not vice versa. Consequently, I consider Avicenna as a Peripatetic and a genuine follower of Aristotle, even though his positions may often not be genuinely Aristotelian.[4] Indeed, Avicenna in many ways exceeds Aristotle by providing novel ways of how Aristotelian materials can be interpreted and integrated, rearranged and refined in innovative ways, often in light of later developments. The result of this appropriation, viz., Avicenna's philosophy as expressed in his various works, must not be taken as a way to comment on Aristotle but as a way to transform and to develop Aristotle.[5]

This understanding of the place of Avicenna's works within the history of Peripatetic philosophy, and of the relation between the Aristotelian corpus and the Avicennian oeuvre, leads to a simple but crucial question: Is Avicenna's natural philosophy as rich and innovative as his logic and his metaphysics already proved to be? – As it happens,

3 Most of these works corresponds to a work from the canon of Aristotle's works. For example, Avicenna's *al-Samāʾ wa-l-ʿālam* corresponds to Aristotle's *De caelo*, *al-Kawn wa-l-fasād* to *De generatione et corruptione*, *al-Nafs* to *De anima*. The cases of *al-Afʿāl wa-l-infiʿālāt*, *al-Maʿādin wa-l-āṯār al-ʿulwiyya*, *al-Nabāt*, and *al-Ḥayawān* are more complicated; cf. also Gutas, *Avicenna and the Aristotelian Tradition*, 103–105.

4 Here I adopt and follow Hasse's distinction between the adjectives "Aristotelian" and "Peripatetic" as a means to describe Aristotle's Aristotelian doctrines as opposed to the Peripatetic interpretations of his followers and commentators; cf. Hasse, *Avicenna's* De Anima *in the Latin West*, x. A similar distinction is applied to Plato's Platonic doctrines as opposed to later Platonist or Neoplatonic appropriations.

5 Interestingly, contemporary Aristotelian interpretations sometimes arrive at conclusions which, incidentally, resemble those found in Avicenna. Two very striking examples in this regard are Morison's solution to the question about the place and motion of the outermost sphere, set out in his *On Location*, and Roark's interpretation of Aristotle's definition of motion and its relation to time, put forth in his *Aristotle on Time*.

this is a question which has not yet received an adequate answer, even though, given the fruitful research on other parts of his philosophy, it clearly deserves a thorough investigation.[6]

However, this does not mean that *no* study of Avicenna's natural philosophy has so far been undertaken. During the last couple of years, a number of insightful and accurate studies on various aspects have been published in the West, in particular by two scholars: Jon McGinnis and Ahmad Hasnaoui.[7] Their contributions provide valuable information on certain concrete aspects of Avicenna's physics, ranging from the structure of his *al-Samāʿ al-ṭabīʿī* as a whole to concrete concepts and their history (as, for example, the concepts of motion or time), and to specific arguments within Avicenna's discussions (as, for example, the proof against circular motion in a void).

What has so far been missing, though, is a study of the foundations of Avicenna's natural philosophy (i) as a whole, (ii) in all his major works, and (iii) in light of the preceding Greek and Arabic traditions. Providing such a study has become the aim of the present dissertation.

Avicenna's *al-Samāʿ al-ṭabīʿī* consists of four books (*maqālāt*, sg. *maqāla*). All the basic concepts of natural philosophy are discussed within the first two books.[8] It is an investigation into these concepts which forms the core of this study. More precisely, it examines Avicenna's accounts of corporeality, matter, form, and privation (in chapter three); nature and inclination (in chapter four); place, space, and void (in chapter five); and time and the now (in chapter six). In addition to that, Avicenna's way of presenting his thoughts in *al-Samāʿ al-ṭabīʿī*, in particular those on matter and form, together with

6 Apart from Marmura's collection of articles *Probing in Islamic Philosophy*, the pioneering studies on Avicenna's metaphysics, in particular as expressed in *al-Ilāhiyyāt*, and on various aspects of how Avicenna conceived of the text of Aristotle's *Metaphysics*, how he restructured its contents, how he interpreted its concepts in light of other sources in the preceding Greek and Arabic commentary traditions, and how he formed his own understanding of the ontology of the world are Wisnovsky, *Avicenna's Metaphysics in Context* and Bertolacci, *The Reception of Aristotle's* Metaphysics *in Avicenna's* Kitāb al-Šifāʾ. Regarding Avicenna's logic, perhaps the best overview over developments within Arabic logic is given in Street, "Arabic Logic". The importance of Avicenna as a logician has already been acknowledged fifty years ago by Rescher; cf. *The Development of Arabic Logic*, esp. 50.

7 cf. esp. Hasnaoui, "La dynamique d'ibn Sīnā"; "La définition du mouvement dans la *Physique* du *Shifāʾ* d'Avicenne"; "La *Physique* du *Šifāʾ*"; McGinnis, "Ibn Sīnā on the Now"; "Positioning Heaven"; "A Penetrating Question in the History of Ideas"; "Avoiding the Void"; "Avicennan Infinity"; "Avicenna's Natural Philosophy".

8 These first two books correspond roughly with the first four books of Aristotle's *Physics*; cf. also Hasnaoui, "La *Physique* du *Šifāʾ*". The third book of *al-Samāʿ al-ṭabīʿī* is concerned with questions which arise from the notion of quantity when applied to natural things. It contains, for example, a refutation of atomism (chs. 2–5) and a discussion of the infinite as such (chs. 8–9), and a number of important issues that relate to the notion of quantity in natural things, such as the finitude of power (ch. 10) and the finitude of natural motion (ch. 14). The fourth book, then, is more miscellaneous in nature and provides a number of various, even though important, studies, most of which are concerned with some aspect of motion, such as the numerical unity of motion (ch. 3), contrary motions (ch. 6), accidental (ch. 13) and forced motions (ch. 14).

the fact that the first chapter in both Aristotle's *Physics* and Avicenna's *al-Samāʿ al-ṭabīʿī* is devoted to methodological concerns of argumentation and presentation within the area of natural philosophy, made it necessary to investigate the over-all method adopted in *al-Samāʿ al-ṭabīʿī* as a whole (in chapter two).

There are two concepts which I decided not to investigate in detail, viz., the concepts of motion and causation. The primary reason for leaving Avicenna's account of motion aside is that there have been two studies which have considerably furthered our understanding of this subject already, viz., Ahmad Hasnaoui's article "La définition du mouvement dans la *Physique* du *Shifāʾ* d'Avicenne" and Robert Wisnovsky's monograph *Avicenna's Metaphysics in Context*. In the former, Hasnaoui provides not only an accurate treatment of Avicenna's notion as expressed in his *al-Samāʿ al-ṭabīʿī*, he also provides valuable material about the history of the definition of motion from Aristotle through the commentators up to Avicenna and, among other things, highlights the influence of Themistius (d. ~ 388), John Philoponus (d. ~ 575), and Abū Naṣr al-Fārābī (d. 339/950-51) on Avicenna's views on motion.[9] Wisnovsky, on the other hand, meticulously analysed Avicenna's understanding of "perfection," "actuality," or "entelechy" (*kamāl*) which, since Aristotle, has been the central notion within the definition of motion. While Avicenna's account of motion is not investigated *as such* in this study, it will, nonetheless, figure prominently and will frequently be mentioned, outlined, or discussed, so that the core idea of Avicenna's account of motion will eventually have been treated *en passant*. On the other hand, Avicenna's discussion of causation in *al-Samāʿ al-ṭabīʿī*, have only peripherally been taken into consideration primarily because Avicenna's main account of causation and the different kinds of cause is carried out in book six of his *al-Ilāhiyyāt*.[10] Although Avicenna, of course, frequently refers to different kinds of cause throughout his writings, questions about causation as such are not investigated in *al-Samāʿ al-ṭabīʿī*. Having said this, the notion of cause – in particular in its its application to matter and form, to nature, and to God, for example – will at appropriate places be integrated and discussed.[11]

This present study, then, investigates all the concepts that are central to Avicenna's natural philosophy with an eye both to important developments in the preceding Greek

9 cf. now also Ahmed, "The Reception of Avicenna's Theory of Motion in the Twelfth Century".

10 Some of these aspects have been treated in publications by Bertolacci, Richardson, and especially Wisnovsky; cf. Wisnovsky, "Avicenna on Final Causality"; "Final and Efficient Causality in Avicenna's Cosmology and Theology"; "Towards a History of Avicenna's Distinction between Immanent and Transcendent Causes"; Bertolacci, "The Doctrine of Material and Formal Causality"; Richardson, "Avicenna's Conception of the Efficient Cause".

11 Other than that, this dissertation does not discuss Avicenna's account of luck and chance in *al-Samāʿ al-ṭabīʿī* I.13–14. For Avicenna, luck and chance are merely accidental causes. This means that, in the final analysis, they have no bearing on the natural world, because a more proper investigation of why a certain effect has come about will eventually reveal its essential causes – and it is these causes which are relevant for the science of nature. Apart from this, Belo has already published an investigation of that topic in her book *Chance and Determinism in Avicenna and Averroes*.

and Arabic traditions, and to parallel or supplementary material from his other major works, in order to examine thoroughly Avicenna's position within the history of natural philosophy and to provide a comprehensive understanding of the key concepts and elements of his physics.

I regret that I could include an investigation of Avicenna's engagement with Muʿtazilī and Aš'arī theology only occasionally and in passing.[12] Likewise, close to no mention is made of later Andalusian figures such as Abū Bakr Muḥammad ibn Bāǧǧa (d. 533/1139), Abū Bakr Muḥammad ibn Ṭufayl (d. 581/1185), and Averroes (d. 595/1198).[13] Perhaps most regrettably, the materials contained in the latter's commentaries on Aristotle's *Physics* could also not be taken into consideration. Moreover, I could not take into account the Latin tradition of reading both Avicenna's *al-Samāʿ al-ṭabīʿī* and Aristotle's *Physics* as well as Averroes' commentary on the latter.[14] Finally, the later Islamic tradition of philosophy and kalām in reaction to Avicenna's philosophical system has almost entirely been neglected, as it will become the subject of my future research within the project "The Heirs of Avicenna: Philosophy in the Islamic East from the Twelfth to the Thirteenth Century."[15]

STRUCTURE AND PROSPECT

The **first chapter** of this study is concerned with providing an account of the transmission of Aristotle's text of the *Physics* and its Greek commentaries into Arabic as well as with a survey of a number of other sources which have been of great importance in the history of natural philosophy up to Avicenna. Most of the texts mentioned in this first chapter will occur, often prominently, in the remainder of this study and will illuminate either how Avicenna himself conceived of certain concepts or how certain figures in the preceding history did to whose conception Avicenna reacts. While Avicenna's *al-Samāʿ al-ṭabīʿī* is at the heart of this study, this first chapter seeks to describe the wide range of texts which form its basis.

The **second chapter** is concerned with Avicenna's method in his writings on natural philosophy. It expounds how Avicenna conceives of his own philosophy in most of his major works and especially in his *al-Šifāʾ*. The general picture drawn out in this chapter is not entirely new and has, in other publications, either implicitly assumed or explicitly

12 A full investigation of this interesting facet is yet to be carried out.

13 cf., however, the relevant material in, among others, Lettinck, *Aristotle's* Physics *and its Reception in the Arabic World*; Belo, *Chance and Determinism in Avicenna and Averroes*; Glasner, *Averroes' Physics*; Cerami, *Génération et substance*.

14 cf. esp. Trifogli, *Oxford Physics in the Thirteenth Century* (*ca. 1250–1270*).

15 This project is scheduled to start in the Spring of 2016; it is directed by Peter Adamson and funded by the *German Research Foundation* (DFG).

addressed.[16] Yet, it has not been looked upon from the specific viewpoint of natural philosophy for which it is, in fact, of utmost importance, not least because it is usually introduced by Avicenna in his major works at the beginning of the section on natural philosophy.

The exposition of Avicenna's views on the principles of natural things, which is carried out in the **third chapter**, may be the most "metaphysical" topic of this study. Incidentally, this is the reason why in this chapter, more than in the others, I had to devote my attention also to the views and opinions expressed by various authors in the secondary literature; there simply exist more scholarly contributions on Avicenna's views on matter, form, and corporeality than on other aspects immediately relevant for his natural philosophy. This, however, does not also entail that the scientific community has already formed an accurate understanding regarding Avicenna's account. To the contrary, it will be shown that the interpretations given in the secondary literature are more often than not inaccurate, as they misrepresent Avicenna's intentions and testify to a misunderstanding of his words.

Avicenna's account of nature as a principle of motion within natural things is an apparent case for Avicenna's engagement with earlier opinions or, more precisely, with one particularly influential earlier opinion. That this earlier opinion has its roots in late-ancient developments in reading Aristotle's *Physics* was to be expected; that it must also be understood in light of the writings of Avicenna's immediate contemporaries and that Avicenna is effectively reacting to an entire, and hitherto unnoticed, tradition of, as he would say, misunderstanding the power of nature, is the central theme of the **fourth chapter.**[17]

Regarding the philosophical understanding of place, Avicenna finds himself in a difficult situation. Rigorously accepting Aristotle's definition with all its consequences, he has to face the opposition of virtually the entire preceding Greek philosophical tradition which, as is well-known, has turned against Aristotle. As is shown in the **fifth chapter**, Avicenna was probably the first in history to systematically defend and successfully restore what for centuries has been ridiculed as an implausible understanding of the reality of place. In addition to the material drawn from the Greek tradition, Avicenna is also reacting to certain trends and tendencies of his own time, especially the views about space and void expressed by the members of the Baṣrian strand of Muʿtazilism.

Time is arguably the most complex notion discussed in Avicenna's *al-Samāʿ al-ṭabīʿī* – more complex than the others and more complex than previous studies have so far noticed. According to the commonly accepted interpretation, Avicenna was influenced by ancient and late ancient readings of Aristotle which described time in terms of a flowing

16 cf. esp. Bertolacci, *The Reception of Aristotle's* Metaphysics *in Avicenna's* Kitāb al-Šifāʾ, ch. 6.

17 I have recently published some materials pertaining to this fourth chapter under the title "Defining Nature" in the collection *Aristotle and the Arabic Tradition* edited by Alwishah and Hayes.

now which generates time much like the tip of a ballpoint may be seen as bringing about a line through its motion over a sheet of paper. It will be shown in **chapter six** that this understanding of Avicenna's account of time is inadequate. Not only did Avicenna reject the idea of a flowing now, his account must also be read against the background of a common Peripatetic confusion about the relation between motion and time. It is this confusion which ultimately is responsible for the increasing complexity of his account, as he struggles to – unwittingly – combine seemingly incompatible Neoplatonic and Peripatetic elements within a single coherent theory.

On the whole, this study will show that Avicenna's take on the core issues and central concepts of natural philosophy is innovative and resourceful in the highest degree. His discussions are rich, his material is vast, his positions are intriguing, and his stance is both rigorously Peripatetic and characteristically Avicennian. Although on a large scale, the structure of his *al-Samāʿ al-ṭabīʿī*, and in particular of its first two books, may appear to follow closely the order of exposition in Aristotle's *Physics*, a more detailed analysis reveals that Avicenna's independence in execution, his resolution in argument, and his innovative power in discussion is tremendous and unmistakable – just as one, given the fruitful research on his logic and metaphysics, should have expected.

Conclusion

In this study, I analysed the core concepts of Avicenna's physics. The central text of my investigation was *al-Samāʿ al-ṭabīʿī*, in which Avicenna gives his most detailed and extensive treatment of natural things. Additionally, I provided further references to parallel passages in his other major works or drew upon these passages themselves, in order to contextualise my discussions and to substantiate my interpretations. Moreover, I also included a study of numerous texts from the preceding Greek and Arabic philosophical traditions, because Avicenna's philosophy can only adequately be assessed in full and appreciated in detail against the background of ancient, late ancient, and early Arabic scientific developments. It is precisely Avicenna's engagement with his predecessors which demonstrates the originality of his thought, the rigour of his analysis, and, ultimately, the strength of his philosophical reasoning.

Yet, it happened that this study did not only analyse "the elements of Avicenna's physics," and so did not only provide a coherent picture of

- how Avicenna conceived of his philosophical method,
- what he thought about matter, form, and corporeality,
- how he envisaged nature as a principle of motion,
- how he defined place, and
- what position within the natural world he attributed to time.

This study also presented different facets of Avicenna's personality as they come to the fore in his way of writing philosophy. So, it happened that, in the second chapter, we became acquainted with **Avicenna the Systematic**, who devised a complex system of interdependent sciences, being related with each other through their principles, questions and subject-matters. Within this complex, physics takes up the second most elevated position, only surpassed in commonality and importance by metaphysics. The science of physics provides the central ideas, the most-important notions, and the crucial elements that lay the foundation of any further investigation of the objects within the natural world. My analysis could show that, in contrast to Aristotle, Avicenna's works do not document his inquiry into the natural world but, instead, follow the requirements of "teaching and learning." It is these two notions which epitomise Avicenna's approach in his major works

and, above all, those works which form his *al-Šifāʾ*. The method of "teaching and learning" not only corresponds to the biographical information about how, when, and why he composed his *al-Šifāʾ*, they also correspond to Avicenna's very own understanding of science as a universal endeavour and to his conception of the philosophical procedure recommended by Aristotle in his *Posterior Analytics*. It could be shown that the style, the structure, and the argument of his *al-Samāʿ al-ṭabīʿī* is nothing other than the rigorous application of these methodological underpinnings to the concrete situation of teaching natural philosophy to his disciples. In presenting the principles of natural things "by way of postulation and hypothesis," Avicenna ultimately followed Aristotle's advice of *Physics* I.1 to proceed "from the universals to the particulars" in a way hitherto unprecedented within the history of philosophy.

On the whole, it may be said that Avicenna's account of the method within his owns writings is the result of a debate between Avicenna and his own self on how to conceive of reality, on how to reproduce that reality in writing, and on how to unfold reality didactically.

In the third chapter, then, we have met **Avicenna the Peripatetic**, who did not follow the Aristotelian method in establishing the principles of natural things through an investigation of change, but who, nonetheless, fundamentally accepted and systematically developed the Aristotelian truth that concrete objects are composed of the constitutive principles matter and form. The resulting philosophical theory is intriguing and systematic. Focussing on the natural body, first, in its fundamental respect of being a body, Avicenna explains that a body as such is a three-dimensionally extended substance. For him, being corporeal means nothing other than being extended in such a way that it is possible to identify up to three distinct and perpendicularly intersecting dimensions. Being extended, moreover, means being essentially continuous which, in turn, entails being essentially divisible. Avicenna's account of the corporeality of natural bodies, thus, intrinsically relies on the three notions of extensionality, continuity, and divisibility. The principle of this threefold meaning of corporeality is what Avicenna calls "corporeal form" which inheres in an underlying substrate called "matter." It is the union of an incorporeal matter and a corporeal form which gives rise to the essentially extended and continuous substance of body. Moreover, Avicenna could demonstrate the existence of this underlying matter on the basis of an argument which essentially relied precisely on the notion of divisibility and continuity, i.e., on the idea of the corporeal form. In this, he was not only fleshing out his own theory but was also critically answering to late ancient arguments which conceived of matter as already corporeal and altogether denied the possibility of proving the existence of an incorporeal matter.

Avicenna's adherence to the idea of a corporeal form as the most fundamental form of body, however, did not commit him to the thesis of the multiplicity of forms, i.e., the ontological thesis according to which concrete objects are constituted through the inherence of two or more forms inhering in one underlying matter. Much to the contrary,

it emerged from this study that concrete objects only have one form, where it is this one form which contains all formal determinations in a unified manner "by way of generality and specificity." A human being, for example, does not exist of matter together with the forms of corporeality, of animality, and of rationality but only of one matter and one form, viz., that of humanity, which makes this human being a rational animate body.

My analysis could also show that Avicenna presented a fundamentally unified physics in which all bodies – eternal celestial and corruptible terrestrial bodies alike – follow the same principles, because they all do not only consist of form and matter; they consist of *the same kind* of matter which is merely distinguished and diversified through different kinds of forms, all of which contain corporeality as their most general and most common formal component. For Avicenna, matter is simply the essentially receptive and not further qualified substrate for form, whereas form is nothing other than a disposition inhering in matter. Thus, matter and form are principles which pertain to all natural beings and are, for that reason, common to all of them. Yet, their commonality is not of a numerical kind, as only God can be said to be "numerically common" to all existent things. Instead, matter and corporeal form are "generically common" precisely insofar as they fulfil a specific function in the natural world, viz., to be receptive for form and to be inherent in matter, respectively.

In addition to his universal analysis of corporality, Avicenna also considered the natural body from a more restricted perspective, viz., insofar as it is subject to change. Change, he argues, is explained through the additional aspect of privation, which signifies the body only insofar as it lacks a certain form. Privation is itself not a principle on equal terms with, and in addition to, form and matter but is merely a necessary requisite for change and motion. As such, privation depends on the two universal principles matter and form, because these constitute what the natural thing is in its *being*, whereas privation only illustrates what a natural thing can *become* on the basis of what it already is.

On the whole, Avicenna's account of principles can be considered to be a result of a debate between Avicenna himself and Aristotle's theory in the *Physics*, as it testifies to his personal appropriation of the principles of Aristotelian natural philosophy by following his own methodological requirements and by answering to the philosophical developments in the works of his late ancient Peripatetic predecessors.

In chapter four, then, we were introduced to **Avicenna the Attacker**, who not only seized John Philoponus' new definition of nature but who took it up with a whole tradition of, as he would have said, misrepresenting the true meaning of nature. Taking his departure from a quotation of Aristotle's definition of nature, Avicenna played out his strengths as a competent commentator not only by providing new insights but also by displaying an acute awareness of intricate issues in previous interpretations. According to his diagnosis, both Aristotle and Philoponus treated the (for him) crucial distinction between nature and soul with less care as actually necessary. While Aristotle could not explain why the motive faculty of the animal soul should not be defined with the very same words as those

he used for defining nature, Philoponus ruined his initially correct understanding of why nature is a "primary" or "first" principle of motion through his subsequent idea which subjugated a body's nature to soul's sovereign command with the result that soul was actually capable of altering the underlying nature, which, again, blurred the distinction between the agency of nature and that of soul. Despite this disagreement, Avicenna fundamentally accepted Philoponus' interpretation that Aristotle's nature must be understood as an active principle involved in the production of motion, instead of being a passive principle of being moved. This was also apparent in his account of inclination, which he adopted from Alexander of Aphrodisias and Philoponus. However, it could be shown that Avicenna considered the idea of inclination to have been rather poorly developed by his predecessors, especially because their accounts failed to draw a clear line between nature, its corresponding inclination, and its effect (i.e., either motion or rest). In Avicenna's theory, however, it is a natural body's nature which brings about an ever identical effect and this effect is its inclination for being at rest in its natural place or state. This entails that upon forcefully moving that body away from its natural place, its nature still effects only one identical effect, viz., the inclination to be in its natural place. Yet, it is this inclination which manifests itself either in what we perceive as weight, when we try to move the body even further away from its natural place, or in a motion back towards its natural place, once the body has been released. Thus, for Avicenna, nature, inclination, and motion are ultimately distinct.

The same urge for clarity and distinction is also present in Avicenna's own classification of natural powers. Systematically differentiating between voluntary and involuntary motions as well as between uniform and manifold motions, Avicenna defined nature as "a power which produces motion and change, and from which the act proceeds in a single manner without volition." In addition to this, he also characterised three types of soul as powers which likewise produce motion and change but from which only one single act proceeds with volition (as in the case of the celestial soul) or from which several acts proceed either with or without volition (as in the case of the animal soul and the vegetative soul, respectively). Ultimately, my analysis showed that Avicenna seized the opportunity to attack Philoponus' account of nature not because of his own personal or singular dissatisfaction with what he found in his predecessor's commentary on the *Physics*, but because it all too aptly epitomised a theory of natural agency which was widely accepted by Greek and Arabic Neoplatonic and Peripatetic intellectuals up to his own time as a complement, or even a rival, to Aristotle's original definition. For Avicenna, however, that understanding of nature was both a superfluous – and actually unsuccessful – attempt to improve upon Aristotle's words as well as a severe distortion of Aristotle's actual intention, because it conceived of nature along the lines of an independent power which merely permeates the bodies it governs. This, as Avicenna rightly asserts, is an account of a universal nature which has no place either in his conception of physics nor in his conception of ontology.

On the whole, then, Avicenna's understanding of nature can be characterised as the result of a debate between Avicenna and the Neoplatonic leanings of his own and earlier times which he personally did not share and emphatically rejected.

In his philosophical investigation of place, then, we discovered **Avicenna the Defender.** Again, Avicenna takes it up with an entire tradition. This time, however, he did not so much attack himself but defend the Aristotelian notion of place which has been discredited and ridiculed already by the earliest followers of Aristotle, whose criticism has been adopted by most of his Greek commentators. This tradition of arguing against Aristotle's account of place found its culmination once more in the writings of Philoponus and even has been applied, under different circumstances, by some Muʿtazilites in the theological tradition of Islam. Consequently, Avicenna was faced with both the shattered and the distorted fragments of a philosophical concept. I have shown how his careful and meticulous analysis of the core idea of Aristotle's definition – the idea of a surface – could gradually restore the definition in three steps. First, Avicenna improved upon Aristotle's *approach* of defining place by investigating the central notion of "surface." This was not only necessary, because of the common Muʿtazilite understanding of place as the surface upon which something rests, but also because a number of Peripatetics, notably Themistius and Philoponus, had a confused understanding of that notion, as they applied it invariably to an outside surface as well as to an inside surface, in order to overcome a common objection to Aristotle's account, viz., that it purportedly cannot account for the place of the outermost sphere and, ultimately, fails to explain its circular motion. Against this Avicenna argued that the outermost sphere does not have a place, even though it still engages in motion. This motion is consequently not a motion in the category of place but in the category of position, as it constitutes a rotation in which the parts of the sphere change their position, while the whole of the sphere stays where it is. In consequence, we could see that Avicenna rigorously emphasised that the idea of place must be conceived as the inner surface of the containing body and cannot be a Muʿtazilite outside surface or simply any surface whatsoever.

In a second step, he turned to the actual *definition* and set out to making it more robust. In particular, Avicenna applied a new strategy for solving what may have been the greatest puzzle to Aristotle's theory, viz., the question how to conceive a body's place when that body itself is located in unstable surroundings. This puzzle was specifically troublesome for Aristotle, because he himself had raised it but, according to his commentators, had been unable to resolve it. Avicenna's reply was a novel analysis of the underlying issue. As we have seen, Avicenna argued that one must inquire whether the body itself was in motion or at rest, instead of focusing on the unstable surroundings. He accepted the only seemingly absurd consequence that the body's place was in constant motion, while demonstrating that this did by no means nullify the distinction between motion and rest, for motion and rest are explained through the presence or absence of the "form of motion" in the body – and this form pertains to the body irrespective of whether its surroundings

are in motion or at rest. Avicenna's analysis brought to light two central aspects of his philosophical reasoning: he was independent enough to disagree with Aristotle, because he rejected the condition that place must be unmoving, and confident enough not only to accept but also to argue for results which have for centuries been credited as absurd or insane or both.

Finally, we have seen how Avicenna could employ what he has defended as a viable account of place within his rejection of the most widespread alternative theory of place, viz., that it must be conceived as an independent three-dimensional space which is void in itself but always filled with body. He argued that this idea of space is invalid for various reasons: it does not exist, it cannot have any influence on bodies, and it cannot have any influence on motion. Ultimately it is the notion of a surface which celebrates its return in the explanation of the mechanisms behind such devices as the clepsydra, thus repudiating the hitherto prevalent idea of the "force of the void." In all this, then, Avicenna did not only defend Aristotle's arguments for place as a surface, he also defended his arguments against place as an extension.

On the whole, Avicenna's take on place can be understood as the result of a debate between Avicenna and the total refutation Aristotle's account had to suffer, leading to the equally total vindication of that same account through Avicenna.

Finally, we have witnessed **Avicenna the Synthesiser**, who devised an entirely novel and ultimately accessible strategy for deriving the essence of time on the basis of an analysis of different motions with different speeds. For Avicenna, time is not the number of motion but is the "magnitude of motion." This magnitude corresponds and conforms to motion, thus indicating the measurable size of that motion. As I could show, however, the idea of understanding time along the lines of a magnitude or a duration has strong Platonist connotations. Ever since Plato has formulated the theory of a stable eternity which is imitated by time as the merely moving image of eternity, it was possible to conceive of motion as the measure of time. Ever since Boethus of Sidon in the second century BC, this idea could be mistaken as an Aristotelian idea, despite the fact that Aristotle defined time as the measure of motion. This understanding, then, did not only reverse the original idea as it was expressed in the *Physics*, it also paved the way for the further idea of time being nothing other than the result of a now which is flowing through eternity, as is demonstrated by Alexander's brief treatise on time, in which Alexander presented time "without deviating from [Aristotle] in any respect" as a duration measured by motion and created by he flowing now. One may surmise that it was ultimately through Alexander that this understanding became a Peripatetic commonplace. Moreover, it was welcomed and positively received by those commentators who generally intended to harmonise Plato's philosophy with that of Aristotle. It was, consequently, hardly surprising to find the same theory expressed in Philoponus' commentary. According to the analysis in this study, however, Avicenna shared only certain parts of this doctrine, in particular by integrating the notion of a magnitude into his account of time.

Furthermore, he conceived of time as that which is "through itself before and after," so that all things in time ultimately derive their temporality, i.e., their individual qualification as being before or being after, from time. He also argued that the motion of the outermost sphere is the cause for the existence of time. Given that this motion is an eternal motion, the result of Avicenna's theory was the existence of an infinite magnitude which is intrinsically structured by the before and after. This infinite magnitude, then, is time. It is, finally, against the background of this time that other particular motions occur. The particular times of these particular motions, in turn, are segments or portions of the eternal time produced by the never-ending revolution of the sphere. In other words, they are magnitudes which itself have been measured out by the individual motion to which they apply. Thus, what Avicenna has done was to unify Aristotle's idea of time being an epiphenomenon of motion with the somewhat Platonist idea of time being a magnitude. In consequence, Avicenna devised a theory of time which accomplishes something which is almost impossible: the complete – even though complex – harmony of two utterly contradictory accounts. It is here that we perceived Avicenna as a capable synthesiser, who laboured (and actually struggled) to put down into words what he conceived as a complicated amalgamation of outright Aristotelian and unnoticed un-Aristotelian elements, when we see him constantly rephrasing certain passages, changing his terminology, and trying to be evermore adequate in his formulations.

Finally, he appended a further chapter in which he elucidated the now and in which he also discussed the image of the flow of a now – not, however, to reveal the essence of time or to demonstrate its existence, for he has already discussed both in the preceding chapter. Instead, Avicenna employed the flowing now to provide a didactic means for his students who may still have had trouble understanding the complexity of his temporal theory. The flowing now imagined as a temporal point pertaining to a thing-in-motion can be mentally represented as producing the extension of the magnitude of time, just as a flowing "where" may help comprehending the extension of a motion and as a moving point could be said to draw out a line. This, however, is neither what time is nor how time comes into being. The now is, generally, something which results from time or, to be more precise, from the continuity of time, which is ultimately safeguarded by its existential dependence on motion and its essential characterisation as that which is "through itself before and after."

On the whole, the discussion of time can be understood as the result of a debate between Avicenna and the Neoplatonic leanings of his own and earlier times which he, this time, at least partially and, perhaps even unwittingly, did share.

Taking it all together, this study contains an analysis of the fundamentals of Avicenna's natural philosophy. It demonstrates the resourcefulness of his writings, the abundance of material contained in his works, and the diligence in his argumentation, thus providing

an answer to the question, which I have raised in the introduction, whether "Avicenna's natural philosophy is as rich and innovative as his logic and his metaphysics already proved to be." At times, my study suggested and established more correct or adequate interpretations as those which could so far be found in the research literature on Avicenna. More often, however, it examined certain topics and concepts for the first time in a western language. My overall methodical intention was to understand Avicenna through a careful analysis of the text of his works as well as through an investigation of the preceding philosophical developments. In this sense, my results put Avicenna's philosophy in its historical context of the Aristotelian tradition, while at the same time positioning his natural philosophy within its systematic context of his own philosophy as it is expressed in all his major works.

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